

# Appendix A: Sources and Methods

## Canada Mexico, and the United States: Overview

U.S. Population, employment, land and water areas, and gross domestic product (GDP) data are from the Bureau of the Census (1992). The Canadian population, employment, and GDP figures are from Canadian Department of Finance (1992). Canadian areas are from Statistics Canada (1991). Canada's territorial water area was obtained by telephone from Environment Canada. Mexican population GDP, employment, exchange rates, and inflation rates are from Consultores Internacionales, S.C. (1992).

## Multimodal Transportation Statistics: 1990

**Transportation Bill.** The 1990 Canadian and U.S. transportation bills are made up of statistics from each modal profile; the 1992 U.S. total is taken from BTS (1994). See the individual profiles for the sources and methods used. The 1990 Mexican total and for-hire transportation bill were roughly estimated as described in table A-1.

Table A-1 Mexico's Transit Transportation Bill: 1990

	Pesos Billion	Canadian Million <sup>1</sup>	U.S. Dollars Million <sup>2</sup>
A. GDP <sup>1</sup>	678,923	281,698	241,386
B. Transport & Commo % <sup>1</sup>	6.760%	n/a	n/a
C. Transport % of Trans. & Commo, <sup>2</sup>	53.400%◀	n/a	n/a
D. = A*B*C; Mexico for hire transport value added to GDP <sup>3</sup>	24,508◀	10,169◀	8,714◀
E. Ratio for-hire "Bill" to value added <sup>4</sup>	2.310◀	n/a	n/a
F. = D*E, Mexico for-hire transportation bill	56,614◀	23,490◀	20,129◀
G. Ratio total Transport Bill/GDP <sup>5</sup>	15.000%◀	n/a	n/a
H. = G*A, Mexico total transportation bill	101,839◀	42,255◀	36,208◀
I. = H-F, Mexico non-for-hire bill	45,225◀	18,765◀	16,079◀
J. = H/Pop., Bill per capita (1,000 Pesos, dollars)	1,253◀	520◀	446◀

### Notes

◀ Denotes estimate

n/a Not available for this report.

1. Published figures "Mexico 1992" Camera Nacional de Comercio de la Ciudad de Mexico.

2. 1990 U.S. experience.

3. The transport sector in GDP typically includes only for-hire transportation. Personal and non-for-hire transport such as private and business use cars and trucks, are considered part of the industry that owns operates them or are part of final demands. Furthermore, GDP is the sum of value added by each sector. Value added is largely the value of labor added by the sector. It does not include inputs purchased from other sectors.

4. Ratio is 1990 U.S. experience; source: "Survey of Current Business," U.S. Dept. of Commerce.

5. This ratio is typical of 15 European nations and of Canada.

6. July 1990 exchange rate of 2,812.6 pesos per U.S. dollar and an average 1990 exchange rate of 1.167 Canadian dollars per U.S. dollar were used.

**Domestic Passenger Travel.** The Canadian and U.S. figures are from the individual 1990 modal profiles. The highway figures are greater than the U.S. totals published in the Federal Highway Administration (FHWA) annual report, Highway Statistics and by the Canadian Royal Commission on National Passenger Transportation (1992). It appears that FHWA used an incorrect preliminary auto occupancy rate in its calculations, which was apparently later used by the Canadian Royal Commission. The Mexican figures were estimated as described in "Domestic Freight Transport," below.

**Domestic Freight Transport.** The Canadian and U.S. figures are from the individual 1990 modal profiles. For Mexico, estimates were developed for vehicles by type, vehicle distance by vehicle type, fuel consumption by vehicle type (for all modes), and highway person-distance and

weight-distance. A major input for these estimates was data on the number of 1990 highway vehicles by type; these data did not, however, include details on truck and bus types. Based on these data and other inputs (noted below), the Mexican estimates were derived as follows.

1. To determine the relative percentages of various types of trucks, 1989 vehicle count data by vehicle type (Mexico Secretaria de Comunicaciones y Transportes 1989) were weighted inversely to the average distance traveled per vehicle by type. U.S. experience regarding the percentage of trucks in each class using diesel fuel or gasoline was used to further categorize trucks by class. The resulting highway vehicle mix is shown in column A of table A-2.
2. U.S. annual highway fuel consumption rates per vehicle for 1985<sup>1</sup> (Research and Special Programs Administration 1993; these rates are listed in column B of table A-2) were then multiplied by the number of vehicles to yield estimated Mexican fuel consumption by mode for 1990. (See column A\*B of table A-2.)

As a check, estimates were developed of fuel consumption by the other modes. Mexican weight-distances and passenger-distances from the modal profiles were multiplied by the

Table A-2 Domestic Freight Weight-Distance: 1990

	A	B	A*B	C	C*A	D	E
	Mexico 1990 Vehicles	U.S. 1985 Gallons/Year per Vehicle	Estimated Mexico 1990 Million Gallons	U.S. 1985 Million Vehicles	Estimated Mexico 1990 Million Vehicle-Miles	Estimated Mexico 1990 Million Person-Miles	Estimated Mexico 1990 Million Ton-Miles
Motorcycles	218,698	50	11	1,669	365	752	n/a
Cars	6,209,449	591	3,670	9,141	56,761	113,521	n/a
Total trucks	2,833,880	n/a	5,787	n/a	43,101	36,078	283,301
2-Axle 4-Tire	1,728,373	846	1,462	10,437	18,039	36,078	n/a
3&4 A unit gasoline	731,864	1,715	1,255	11,962	8,755	n/a	98,963
3&4 A Unit diesel	109,195	1,715	187	11,962	1,306	n/a	14,765
Combo diesel	264,448	10,899	2,882	56,725	15,001	n/a	169,572
Buses gasoline	33,016	1,311	43	10,145	335	8,374	n/a
Bus tran & IC, diesel	54,511	8,879	484	36,859	2,009	264,599	n/a
Highway gasoline	8,921,400	n/a	6,441	n/a	84,254	158,725	98,963
Highway diesel	428,154	n/a	3,553	n/a	18,316	264,599	184,338
Total highway	9,349,554	n/a	9,995	n/a	102,570	423,324	283,301
RR diesel	n/a	n/a	143	n/a	n/a	n/a	n/a
Ton-miles	24,941	88	n/a	n/a	n/a	n/a	n/a
Pass.-miles	3,358	54	n/a	n/a	n/a	n/a	n/a
Water, diesel	n/a	238	n/a	n/a	n/a	n/a	n/a
Aviation, jet fuel	n/a	209	n/a	n/a	n/a	n/a	n/a
Aviation, gasoline	n/a	5	n/a	n/a	n/a	n/a	n/a
<b>Estimate      Product</b>							
Total Gasoline	6,655	6,632					
Total Diesel	3,934	3,965					
Total Petrol	10,589	10,597					

1990 U.S. fuel consumption rates per weight- and passenger-distances (Research and Special Programs Administration 1993, FHWA annual series). For purposes of this analysis, it was assumed that half the fuel used in Mexican international aviation was

purchased in Mexico. Total fuels consumed by type were summed and compared with the actual amounts of fuels produced in Mexico (Consultores Internacionales, S.C., 1992); these are listed in the Estimate and Product columns at the bottom of table A-2. The estimated gasoline figure was 0.3 percent higher, and the diesel fuel estimate was 0.7 percent lower, than the actual figures. The estimated total for petroleum-based transport fuels was the same as the actual figure to three decimal places.

3. Next, estimates were calculated for Mexico's 1990 vehicle miles by vehicle type. To do so, Mexican vehicle estimates were multiplied by the corresponding U.S. distance-per-vehicle (column C of table A-2). (See column C\*A of table A-2.)
4. Highway person-distances were estimated by multiplying the car and two-axle, four-tire truck figures by an assumed average occupancy rate of two (column D of table A-2). The U.S. 1990 experience was an average occupancy rate of 1.8 (ORNL forthcoming), but Mexico has a larger average family size than does the United States: this would probably translate into a larger average occupancy rate. Weight-distances were estimated by multiplying truck distances by an average load based on the experience of U.S. Interstate Commerce Commission motor freight carriers, classes I and II (regression analysis was taken from American Trucking Association data). (See column E of table A-2.)
5. Data on the number of U.S. trucks and truck-miles and fuel type for 1987 are from Bureau of the Census (1987b).

**Vehicles.** The Canadian and U.S. figures are from the 1990 modal profiles. The figures for Mexico came in part from the 1987-91 modal profiles, supplemented by statistics from Mexico Secretaria de Comunicaciones y Transportes (1989). Allocation of total trucks to truck classes was done as described in "Domestic Freight Transport," above. Mexican fishing boats were estimated by multiplying the ratio of weights of Mexican and U.S. catches by the U.S. fleet. Mexican recreational boats were estimated by multiplying the U.S. fleet by the ratio of the Mexican per capita GDP to the U.S. per capita GDP.

**Fuel Consumption.** The Canadian and U.S. fuel use figures were summed from the individual 1990 modal profiles. The estimates of the 1990 Mexican petroleum fuel use figures were derived as discussed in "Domestic Freight Transport," above. Electricity used by Mexican transit vehicles was estimated using Canadian and U.S. annual consumption per vehicle figures multiplied by the numbers of operating Mexican vehicles. Caution should be exercised in comparing the use of electricity and petroleum-based fuels. U.S. electricity generation and distribution efficiency is approximately 29 percent (ORNL 1993). If that power efficiency figure is applied to Canada and Mexico, the kilowatt-hour consumption by mode of transit should be multiplied by 3.45 to estimate the power that must be generated for transit operations.

**Transportation Employment.** The employment statistics presented understate the total employees in transportation. They do not include business (other than for-hire transport business) and government car drivers, bus drivers, and vessel crews. They also do not include people employed by the fishing industry, although a portion of commercial fishing operations involves getting to the fishing site and returning with the catch.

Canadian and U.S. figures are from the 1990 modal profiles. In general, they are based on officially reported statistics. Comparable official statistics did not exist for Mexico. With the exception of rail employment, the Mexican figures are rough estimates based on the Canadian or U.S. experience as described in the remainder of this section.

The Canadian highway manufacturing figure was multiplied by the 1988 ratio of Mexican to Canadian motor vehicle production: 1990 Mexico, 600,000 vehicles; 1989 Canada, 2,043,104

vehicles (MVMA 1989). The Canadian aviation manufacturing employment (which includes parts) was multiplied by the ratio of the Mexican air vehicle fleet to that of the Canadian. Mexico manufactures (and reconditions) rail vehicles for its national railroad; however, the employees involved in this activity were probably included in the overall employee count for the railroad. Canadian water manufacturing employment was multiplied by the ratio of Mexican water vehicles to Canadian.

The Canadian construction figure was multiplied by the Mexican to Canadian ratio of paved road distance.

Mexican operating employment statistics were estimated as follows. Canadian bus, air carrier, water, and electric transit employment were multiplied by the ratio of the relevant Mexican to Canadian vehicle fleets. Total Canadian employees per truck were multiplied by the number of Mexican trucks to estimate total Mexican trucking employees. The Mexican taxi operator estimate was based on Mexico City experience multiplied by an estimated Mexican metropolitan population. Consultores Internacionales, S.C. (1992), reports 1,045 employees in Mexico's transport storage and communications sector in 1990. The U.S. experience (BE A monthly series) was that 53 percent of transport and communications employees were in transportation. Multiplying the Mexican employment figure by the U.S. experience yielded an estimated 554,000 employees in Mexican for-hire transportation. After subtracting out employment in the other commercial modes, the residual was an estimate of Mexican for-hire truck employment; subtracting this amount from total Mexican truck employees yielded estimated private or business use truck employment.

The "other commercial" transportation employee in table 8 includes retail and wholesale trade, brokers, agents and forwarders, and airport and water services. The Canadian highway-related figures were multiplied by the Mexico/Canada ratio of highway vehicles. The Canadian aviation-related numbers were multiplied by the Mexico/Canada ratio of public airports. The Canadian water-related values were multiplied by the Mexico/Canada ratio of total weight handled (domestic and international). Canadian transport-related employees were multiplied by the Mexico/Canada ratio of paved road distance.

**Transportation Fatalities.** These figures came from the individual 1990 modal profiles and the 1987–91 modal trend profiles.

### **Transborder and Other International Transportation Statistics**

Traveler and expenditure statistics between the United States and other countries are from table 408, U.S. Travel to Foreign Countries—Travelers and Expenditures: 1984 to 1991, and table 409, Foreign Travel to the United States—Travelers and Receipts: 1984 to 1991 in Bureau of the Census (1992). Traveler statistics between Canada and the rest of the world are from International Travel Section (annual series), specifically the 1990 and later editions. Canada to Mexico travelers are rough estimates based on data in Aviation Statistics Centre (1991). Traveler and travel expenditures between Mexico and the rest of the world are based on table 9.4 in Consultores Internacionales, S.C. (1992).

There is no standard valuation of imports and exports between countries. Therefore, various inputs were used to determine a valuation. These inputs included each nation's total value of imports and exports, U.S. and Canadian export values, and Mexican export values to the United States. Trade and weight values between the United States and other nations are from table 1335 in Bureau of the Census (1992). Value of trade flows between the United States, Mexico, and Canada are from tables 2-2 through 2-5 in FHWA (1993). U.S. weight flows between the United

States and Canada are based on data in Agricultural Marketing Service (1991). Data on value of trade between Canada and other countries are from Statistics Canada's by-country import and export reports. Mexican trade values are from Consultores Internacionales, S.C. (1992). Additional detail on Canada-U.S. trade flows by mode is from Statistics Canada (annual series [f], [g], and 1990b).

### Modal Profiles: 1990

**Highway.** In both Canada and the United States, there is a lack of statistics on the number, use, and costs of trucks operated by firms that are not primarily involved in for-hire trucking. An initial step in developing the highway profile was estimating statistics in these areas for both Canada and the United States.

For Canada the process involved the following. First, total truck registrations (with "other road motor vehicles" included as per Statistics Canada annual series [e]), were allocated to various truck types and types of operation, maintaining the integrity of the total truck and Statistics Canada survey samples. The fiscal and operating statistics of for-hire carriers were summed and used. The straight trucks and tractor sums of for-hire carriers (from Statistics Canada annual series [g], including owner operators) were subtracted from the total registered trucks. Statistics Canada (annual series [g]) contained statistics on total owner-operators and on use of owner-operator vehicles by for-hire carriers. Subtraction of the for-hire owner-operator vehicles from the total owner-operator vehicles yielded an estimate of the owner-operator vehicles used by not-for-hire firms. Statistics Canada (annual series [g]) has some survey statistics of private (not-for-hire) trucking including straight trucks and tractors owned and purchased as purchased transportation from owner-operators. The ratio of total owner-operators to the sample of private owner-operators was multiplied by the private sample truck figures to yield estimated Canadian totals. The total private (not-for-hire) trucks were subtracted from the remainder of total registered trucks less for-hire trucks. The substantial remainder apparently included vehicles such as farm utility trucks and personal-use vehicles. Statistics Canada indicated (by phone) that there were more than 500,000 farm trucks that were not in the Canadian sample (Statistics Canada annual series [g]). U.S. experience in 1987 for the same classes and types of vehicles (using data from Bureau of the Census 1987[b] and American Trucking Association [annual series]) was used to allocate the remainder among vehicle types. (See table A-3.) The trucks by type and user class were multiplied by annual average travel

Table A-3 Estimated Canadian Trucks

	Total Thousands	Percent	1990 Private Business Thousands	1990 Private Personal Thousands	1990 For-Hire Carrier Thousands	1990 For-Hire Operator Thousands
<b>Total Trucks</b>	3,936.1	100.0	1,201.5	2,643.9	58.5	32.2
Single Unit	3,848.8	97.8	1,181.2	2,643.9	14.5	9.2
2 Axle	3,579.6	90.9	936.2	2,624.1	12.5	6.7
>2 Axle	269.3	6.8	245.0	19.7	2.0	2.5
Tractor	87.3	2.2	20.3	0.0	44.0	23.0

Note

Farm trucks and "Other motor vehicles" included in "Private Business."

distances rates, fuel use, loads hauled, and revenue or expense rates. The averages were from survey data (Statistics Canada annual series [g]) or from U.S. experience (Bureau of the Census 1987[b]).

Canadian highway bill estimates were then made for small vehicles, which included cars (but not taxis) and personal-use two-axle, four-tire trucks. The number of cars came from national registrations (Statistics Canada annual series [e]); the number of personal-use trucks are from the process outlined above. Annual capital and operating costs per vehicle, taken from Statistics Canada (1990a), were multiplied by the number of small vehicles. Taxi revenues are from Statistics Canada (1989); this source also provided the estimate of the number of taxis subtracted from the small vehicle fleet. Bus revenues, except for transit buses, are from Statistics Canada (annual series [c]). Transit bus revenues, and most other transit statistics, were estimated by allocating the totals for all transit modes from Statistics Canada (annual series [c] and American Public Transit Association (1992) to individual transit modes using U.S. cost and operating experience. For-hire truck revenues came from Statistics Canada (annual series [g]).

Business truck expenses were estimated in two parts. The first part covered business trucks included in the Canadian private truck surveys (Statistics Canada annual series [g]). The expenses reported in the survey were multiplied by the owner-operator ratios previously described. The second part covered farm trucks and "other motor vehicles" not accounted for in the private truck surveys. These trucks were divided into two-axle and greater-than-two-axle classes based on U.S. experience. The average annual operating cost per vehicle-distance is from Statistics Canada (1990a); this was divided by 0.7 and multiplied by the number of vehicles to yield the estimate. (The 0.7 value, which was based on U.S. experience, was used to account for driver costs.) Greater-than-two-axle vehicles were multiplied by U.S. vehicle-distance per year (Bureau of the Census [1987b]); the result was multiplied by U.S. cost per vehicle-distance experience (GSA [annual series]), divided by 0.7. The 1987 Canadian government expenditure and revenue figures from Transportation Association of Canada (1988) were increased to account for 1987-90 inflation. The figures may be in error, since the Canadian tax system has changed since 1987. IRF (1991) is another source for governmental road expenditures, but it does not provide as much detail. Data were not available on motorcycle costs.

Canadian road distance data are from IRF (1991), and were checked against a less complete set of figures in the 1990 edition of Statistics Canada (annual series [g]). Canadian vehicle, vehicle-distance, and motor fuel consumption figures were estimated in the same general way as revenues and costs. No separate accounting was made for Canadian motor vehicle travel in the United States, since data were unavailable to allow for such estimation. The 1989 survey of for-hire trucking firms with revenues greater than \$1 million in Canadian dollars (Statistics Canada annual series [g]) showed that in 1989, 4.8 percent of the fuel that the trucks in the survey consumed was purchased in the United States.

Total fuel consumption estimates are slightly greater than those in Statistics Canada (annual series [d]), which do not include foreign fuel. Person-distance data were estimated by multiplying U.S. average occupancy per unit distance by the corresponding Canadian vehicle distance. Canadian business weight-distance figures were estimated by multiplying the ratio of Canadian to U.S. vehicle-distance by vehicle type by the corresponding U.S. weight-distances.

Canadian highway-related for-hire employment statistics are from Labour Division (1990). Business trucking labor was estimated by multiplying the number of employees in the Canadian private truck survey (Labour Division 1990) by the ratio of survey expenses to total expenses (estimated as previously described). The resulting estimate of 216,000 employees apparently

understates the total. Statistics Canada (1993) shows 347,000 employees (truck drivers and forepersons in motor carrier operations and motor transport operating occupations not elsewhere covered). Subtracting the for-hire truck employees (Statistics Canada annual series [g]) from this number yields a remainder (apparently private and government truck employees) of 242,000. Statistics Canada (1993) shows an additional 189,000 employees in materials handling and related occupations (longshore workers, stevedores, and freight handlers were subtracted from the total). A large proportion of these must also be involved in the handling of truck freight.

The estimates are understated for highway employees for other reasons. Many people that operate vehicles for business purposes do not identify their occupation as motor vehicle operators although a significant part of their work hours are devoted to such operation. These people probably include police and security officers, military personnel, fire truck and ambulance drivers, farmers, newspaper delivery and garbage collection vehicle operators, route sales workers, and drivers of many other types of utility or service vehicles. There are more than 455,000 persons in such occupations, but data are not available regarding how much of their working hours are spent in motor vehicles.

Canadian road fatalities are from Transport Canada (1991b). The U.S. highway bill for small vehicles, taxis, and school buses is from Eno Transportation Foundation (annual series). The Eno Foundation develops the small vehicle costs by supplementing statistics from BEA (monthly series); its estimates of auto debt interest are based on financing statistics from Bureau of the Census (1992); its car registration and operators permit fees are from FHWA (annual series). The totals are then multiplied by 1.15 to account for business use of small vehicles. Eno estimates taxi costs by multiplying taxi personal consumption expenditures from BEA (monthly series) by 1.45 to account for business as well as personal use. Eno estimates school bus costs by multiplying school bus miles as published by the National Safety Council.

Intercity bus and "other bus" revenue are from an undistributed report on a membership survey by the American Bus Association. Bus transit expenses are from American Public Transit Association (1992). For-hire truck revenues are from Bureau of the Census (1990). Business truck costs were estimated as follows. Total 1990 unit trucks and tractors from FHWA (annual series) were multiplied by the ratios of business-to-total developed from Bureau of the Census (1987[b]). Vehicle-distance of each type for 1990 (also from FHWA annual series) were then multiplied by the ratio of private to total trucks to estimate vehicle-distance by type. The vehicle-distances for each type were then multiplied by average operating cost-per-vehicle from GSA (annual series), divided by 0.7 to account for driver costs. Total (federal, state, and local) 1990 road-oriented revenues and costs are from Office of Economics (1991).

The highway-distance statistics are from IRF (1991), and were reproducible from statistics in FHWA (annual series). Vehicle, vehicle-distance, and fuel consumption statistics are from FHWA (annual series). Person-distances were estimated by multiplying the vehicle-distances by vehicle type by corresponding national vehicle occupancy rates from the FHWA 1991 National Personal Transportation Survey. Weight-distance statistics were estimated by multiplying truck vehicle-distances by an average national load based on American Trucking Association (annual series) statistics.

Employment statistics—except for private tracking, urban transit, and school buses—are from the Department of Labor's Bureau of Labor Statistics (BLS) (annual series). Private truck employees are from table 22 in BLS (annual series). Bus transit employment data are from American Public Transit Association (1992). School bus employees were estimated by multiplying the number of school buses by an average number of employees per bus; that

average was estimated from unpublished American Bus Association statistics. The employment estimates understate total highway employment for the same reasons as described above for Canada. Data on fatalities are from Research and Special Programs Administration (annual series).

**Aviation.** The air carrier items in the Canadian aviation bill are from Statistics Canada (annual series [a] and a 1990 quarterly service update). Private aviation expenses were estimated by multiplying U.S. cost by the ratio of Canadian to U.S. active private aircraft. The Canadian private aircraft statistics are from Aviation Statistics Centre (annual series). Government services and facilities minus revenue figures are from Transport Canada (1991a). They apparently include TDC aviation-oriented research. No data were available on provincial or local aviation revenues and costs.

Canadian airport statistics are from Statistics Canada (1989). Canadian aircraft statistics are from Statistics Canada (annual series [a]) and Aviation Statistics Centre (annual series). Air carrier fuels are also from Statistics Canada (annual series [a]). General aviation fuels were estimated by multiplying the ratios of Canadian to U.S. general aviation aircraft by type by the U.S. values. Employment data are from Labour Division (1990). Transport Canada (1991b) is the source of fatality statistics.

U.S. aviation bill statistics are from Eno Transportation Foundation (annual series). The Eno foundation uses *Air Carrier Financial Statistics*, published by the U.S. Department of Transportation, as its main source of air carrier data. The foundation developed general aviation capital costs from values published by the Aerospace Industries Association. The total industry domestic billings were multiplied by 1.25 to reflect a 25-percent markup in sales; the value of imports was added to this total. Operating costs are based on historical operating cost per aircraft hour ratios, updated to account for inflation, multiplied by current hours. The reliability of the operating cost figures, 65 percent of the total, is questionable, but other data were not available. Revenues and costs of government programs are from Office of Economics (1991), as modified by the cost allocation percentages in Office of Aviation Policy and Plans (1991). This source allocates 62 percent of Federal Aviation Administration outlays to air carriers, 26 percent to general aviation, and 12 percent to public purposes (such as military aviation).

U.S. airport and aircraft statistics are from Bureau of the Census (1992), which attributes its statistics to the U.S. Department of Transportation, Federal Aviation Administration. Domestic air carrier passenger and weight-distance are from Eno Transportation Foundation (annual series); the corresponding international statistics are from Research and Special Programs Administration (1993). U.S. "other civil aviation" passenger-distances were estimated so as to correspond with Canadian aviation definitions. This process was based on data from Office of Management Systems (1990). Fuel consumption figures were reported in FAA (1991). Aviation employment data are from BLS (annual series). Aviation fatalities are from Research and Special Programs Administration (annual series).

Other sources consulted for aviation data include Aviation Statistics Centre (1991), Policy and Coordination (1992a and 1992b), Statistics Canada (1991a), and Transport Canada's Aerodrome Certification and Enforcement (phone contact).

**Rail.** Except for a few specific items, all the Canadian financial and operating statistics are from Statistics Canada (1990b). Additional subsidy statistics are from Transport Canada (1991a). Employment data came from Labour Division (1990); fatality statistics are from Transport Canada (1991b).

In general, the U.S. rail freight and Amtrak revenue and operating statistics are from Eno



Transportation Foundation (annual series). The revenues are from the table of Revenues of Federally Authorized Domestic Carriers, not from the freight and passenger bill tables. Commuter rail expenses and operating statistics are from American Public Transit Association (1992). Governmental outlays and revenues are from Statistics Canada (annual series [g]). Employment statistics are from BLS (annual series); fatality statistics are from Research and Special Programs Administration (annual series).

**Water.** Even though they may not typically be classed as transportation, recreational boating and some portion of fishing vessel expenses should be considered part of the water bill since they use government-provided services and facilities (ports, harbors, waterways, water navigation and communications, search and rescue services, policing and regulatory activities, etc.). Therefore, recreational boating is included in the water bills discussed. Fishing is not, however, because there was no meaningful way to allocate fishing financial statistics between transport activity (i.e., getting to the fishing area and returning with any catch) and the act of fishing. In 1990, the U.S. commercial fishing fleet catch of 4.9 million tons was valued at about \$3.6 billion; the industry employed about 274,000 (Bureau of the Census 1992, tables 1149-57). If the entire U.S. catch were included in the water bill, it would increase it by roughly 91/2 percent. Canadian occupation statistics indicate that there are roughly 43,000 persons employed in fishing (Canadian Royal Commission on National Passenger Transportation 1992); this is about 16 percent of the U.S. figure. Multiplying this figure by the U.S. catch value yields a 1990 Canadian catch value of roughly \$567 million (\$662 million in Canadian dollars). If this amount were added to Canada's water bill, it would increase it by about 17 percent.

Except for boating, the Canadian water bill domestic and international statistics are from Statistics Canada (annual series [f]). The boating expenditure figure is from Allied Boating Association of Canada (annual series); the association's 1990 figure, which is rather large, was based on numbers of boats by type multiplied by unit costs. The estimates of unit cost involved annualized boat sales values, and available operating cost information. The Statistics Canada estimate of boats may be high. Statistics Canada (annual series [b]) reports 1,780,000 boats owned by households in 1990; Statistics Canada (annual series [f]) reports 2,300,000 boats. However, the former figure excludes business-owned boats. The unallocated federal support figures are from Transport Canada (1991 a).

The Canadian boating fleet statistics are from Allied Boating Association of Canada (annual series). The number of Canadian fishing fleet vessels of over five tons and of "other" fishing vessels are from a September 1, 1993, letter from Peter J. Ady, Superintendent of Ship Registration and Tonnage Measurement, Canadian Coast Guard. The number of motorboat fishing fleet vessels was estimated by multiplying the U.S. figure by the ratio of Canadian to U.S. vessels over five tons. There may be double counting between the recreation boat and fishing vessel statistics. The remaining water fleet statistics are from Statistics Canada (annual series [f]).

Canadian water freight-distance was estimated by multiplying the 1992 tonnages loaded by the ratio of 1990 to 1992 tonnages loaded by average trip lengths. The figures, which exclude fishing fleet estimates, are from a July 6, 1993 letter from Richard Hinchcliff, Director, Statistics and Forecasts, Transport Canada; and Statistics Canada (annual series [f]).

Domestic diesel fuel and gasoline consumption for shipping is also from Statistics Canada (annual series [f]); 9.2 million liters of lubricating oil and 1.7 million liters of "other fuel" were excluded. Recreational boat gasoline was added to the shipping fuels. It was estimated by multiplying the average U.S. consumption per inboard and outboard motorboat (FHWA annual series, Bureau of the Census 1992) by the number of Canadian motorboats. Canadian residual

fuel consumption was estimated by multiplying the ratio of Canadian to U.S. international ton-mileage by the U.S. water residual fuel consumption.

Canadian water employment statistics are from Labour Division (1990); they apparently do not include any of the 43,000 persons in the fishing industry. If these persons were included, they would more than double total Canadian employment in water operations.

Total water fatalities are from Transport Canada (1991b). Water transport fatalities are limited to ferryboat fatalities as reported in Canadian Royal Commission on National Passenger Transportation (1992). The recreational boating figure is the total minus the ferryboat figure; to the extent that there were water shipping fatalities, the recreational boat statistic may be in error.

The U.S. domestic for-hire freight and passenger bills, and the international water passenger bill were estimated by multiplying the 1987 figures (Bureau of the Census 1987a) by the ratio of the 1990 industry payroll to the 1987 payroll (BLS annual series). The domestic water support figures are from Office of Economics (1991). U.S. boating expenditures are reported in Bureau of the Census (1992), table 395. The international freight figures are from Eno Transportation Foundation (annual series), which attributes these figures to the Bureau of Economic Analysis. Federal support of international shipping data are from Maritime Administration (annual series). The unallocated state and local government support figures are from Office of Economics (1991).

U.S. vessel statistics are from three sources—Bureau of the Census (1992), table 395 for recreational boats; Bureau of the Census (1992), table 1150 for fishing vessels; and Office of Trade Analysis and Insurance (1991) for other vessels.

International weight-distances for imports and exports were estimated by multiplying the U.S. tons unloaded and loaded from Water Resources Support Center (annual series) by the Canadian average import and export distances (from July 6, 1993, letter from Richard Hinchcliff, Director, Statistics and Forecasts, Transport Canada). Water fuel consumption figures are from Research and Special Programs Administration (1993), which reports its sources as the U.S. Department of Energy, Energy Information Administration, for residual and diesel fuels and the Federal Highway Administration for gasoline. Water employment data are from BLS (annual series); these figures exclude all 274,000 people employed in the fishing industry. If these people had been included, the water operations employment figure would be about six and a half times larger than it is. Water fatalities statistics are from Research and Special Programs Administration (annual series).

Additional sources consulted for water mode data include Coast Guard (1990) and Maritime Administration (1989).

**Transit.** Total nationwide transit figures all variables and for the numbers of vehicles operated by mode are from Statistics Canada (annual series [c]) and American Public Transit Association (1992); Canadian fuel consumption and operating and capital subsidies are in Statistics Canada (annual series [c]); data on vehicle miles, operating revenue, operating expense, and employees are in American Public Transit Association (1992). All the U.S. financial and operating statistics, except for governmental subsidies, came from American Public Transit Association (1992). The governmental subsidies are from Office of Economics (1991a).

Canadian by-mode estimates of the variables were estimated from the totals and the numbers of vehicles, using U.S. per vehicle experience. The summed estimated totals were within several percentage points of the reported totals. The matrix of variables was then multiplied by the ratio of the reported totals to the estimated totals.

**Oil Pipeline.** The Canadian oil pipeline data are from Energy Section (1991); cubic meters

have been converted to tonnes and tons, and cubic meter kilometers have been converted to tonne-kilometers and ton-miles. U.S. data are from Eno Transportation Foundation (annual series). The foundation bases its estimates on statistics collected by the U.S. Department of Energy, Federal Energy Regulatory Commission.

**Modal Trends: 1987-91**

The beginning set of statistics in each mode is from IRF (1991). Where similar, more authoritative statistics from those previously described were available, they were used. Many of the statistics for Mexico came from Consultores Internacionales, S.C. (1992).

**Endnote**

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1. The year 1985 was selected because the average age of Mexico's highway fleet is probably older than that of the United States.